My invention relates to the art of building concrete structures and particularly to the building of concrete structures reinforced with structural steel rods and other elements.

Such reinforced concrete structures are in very wide use because of the great variety of forms which may be constructed wholly or in part of this material, but has hitherto been subject to the disadvantage that a large wastage of lumber was involved in their construction.

In erecting buildings, bridges, culverts or pipes, or other structures, forms made from wood are first shaped and arranged to define inner and outer surfaces of walls, arches and the like, reinforcing steel rods and other elements being put in place in the form, and the concrete then poured into the form and allowed to set after which the forms are removed and reused for another portion of the structure or if there was no further use for them were scrapped, since very few identical structures are erected, especially within a short period which would justify the expense of storing the forms for further use.

It is the particular purpose of my invention to reduce to a minimum the wastage of lumber incidental to the erection of reinforced concrete buildings by the provision of demountable wooden forms fitted with metal clamping members.

An important object of my invention is to provide a novel method using wooden forms in forming concrete structures and which forms may be wholly or in part reused indefinitely, any parts necessarily destroyed in one use being readily replaced for a further use of the forms.

A further object of my invention is to provide a novel method for rapidly and accurately erecting wooden forms by the use of a plurality of steel spacing elements utilized to locate the reinforcing rods in the forms, the forms being freed from the spacer elements after the concrete has set and dismantled for further use while the spacer elements are left embedded in the concrete.

It is a still further object of my invention to provide a novel method for producing tubular structures of reinforced concrete such as storm drains, culverts and the like including boards held in position to provide inner and outer forms held by inner removable rings and outer removable straps against a hooplike spacing member left embedded in the concrete and permanently secured to a longitudinally extending base, while the inner and outer form boards and straps may be dismantled for reuse.

Still another object of my invention is to provide improved methods of erecting concrete structures such as walls, floors and tubular structures with rapidity and accuracy.

Yet another object of my invention is to provide a novel method of constructing forms for concrete construction without the use of nails by the use of which method any lumber or other surface defining elements, and metal members used to hold the forms in assembled position, are not marred or in any way injured by repeated use.

Another object of my invention is to provide a novel method of building concrete structures of extended length, such as pipes and conduits, by which the alignment of the conduit along its predetermined course, whether straight or not, is greatly facilitated.

A still further object of my invention is to provide a novel method of constructing forms for use in building reinforced concrete structures by which the reinforcing steel rods are positively held in position without the necessity of wiring the rods in position, thus greatly reducing the time of setting up the forms and reinforcement preparatory to pouring the concrete, as compared to the procedures in use hitherto.

Another object of my invention is to provide a novel method of constructing reinforced concrete structures by which the time of erection of the structure is reduced together with the cost of material used in the forms and the necessity of employing expensive labor in the placing and securing in position of the reinforcement rods is avoided.

Other objects, advantages and features of invention may appear from the accompanying drawing, the subjoined detailed description, and the appended claims.

The accompanying drawings illustrate the invention in the form 1 at present deem preferable.

Fig. 1 is a side elevation in which forms in carrying out my invention are arranged to produce drains and the like.

Fig. 2 is a cross-section on the line 2—2 of Fig. 1.

Fig. 3 is a cross-section on the line 3—3 of Fig. 2.

Fig. 4 is a detail view of an outside removable member shown in Figs. 1 and 2 in assembled relation.

Fig. 5 is a detail view of an inside removable member shown in Fig. 2 in assembled relation.

Fig. 6 is a detail view of a skeleton ring mem-
ber left embedded in the structures shown in Figs. 1 and 2.

Fig. 7 is a section through a modified form construction used for constructing culverts and the like and particularly applicable to the construction of relatively small diameter structures.

Fig. 8 is a detail view in elevation of a structural reinforcement member utilized in the construction shown in Fig. 7 and left embedded in the structure.

Fig. 9 is a fragmentary detail in section showing one way of forming an expansion joint in a length of conduit utilizing elements of my novel form construction.

The reusable forms of my invention are characterized by the use of planks or boards connected together and also spaced by iron or steel members, some of which may be left in a completed portion of the structure but which may be readily replaced by new and inexpensive parts in order to put the form in condition for use in forming a further portion of the same or another structure.

In Figs. 1 through 6 I illustrate the application of the forms of my invention to the production of horizontally extending tubular structures such as storm drains and the like.

In this form of the invention metal hoop members H, Fig. 6, effective to support boards or planks defined and supporting the inner and outer surfaces of the tubular structure during the construction are left embedded in the concrete structure.

The tubular structure is first provided with a longitudinally extending sub-base B serving as a permanent anchorage for the hoop members left embedded in the concrete.

The sub-base B is poured in the ordinary manner to provide a thick slab reinforced with longitudinally extending sub-base B and short vertical rods 80 projecting upwardly therefrom and with laterally projecting spaced bolts 82, the bolts preferably being provided with anchor plates 82a. When a length of the sub-base B has sufficiently set hoop members H are placed in position. Members H are built up from an inner continuous hoop 84 of strip material and an outer member 86 with its ends formed as downwardly projecting securing lugs 88c provided with openings therein. The members 84 and 86 are spaced apart by spacers which may be formed as a plurality of circumferentially spaced plates 87 welded to the members 84 and 86. The hoop members H are secured in vertical position at spaced intervals by passing the holes in ears 86b over the projecting ends of bolts 82, then positioning the bottom length of an outside form built up of lengths of board or plank 90b and then securing an outer hoop member 86 by apertured lugs 90c on the ends of bolts 82 and finally clamping the assembly together by nuts 82a.

The hoop members may be held in spaced parallel planes by longitudinal reinforcing steel rods 91 which may be spot welded to spacer plates 87 or otherwise secured thereto and circumferentially reinforcing steel rods 91a which may be then put in place. Rods 91a are bent to circular shape with their ends bent outwardly so as to be embedded in the upper layer of base B when the cement is poured.

The outer hoop is, of course, concentric with the outer member of hoop H and the planks 90b forming the outer wall of the form are positioned therebetween. A gap 90 is left extending longitudinally along the top through which the con-
jecting ends of the straps and when nuts 182a are tightened up, stable guides will be formed between which the form boards defining the outer surface of the form may be slipped. After concrete has been poured and set, the outer straps and boards may be readily removed for re-use.

It will be noted that the construction described for forming conduits provides a self-aligning structure once the base has been laid since the preformed reinforcing members and form members accurately assume their proper positions without the need for elaborate lining up as is usual practice. It is, of course, not necessary that the base should follow a straight line either horizontally or vertically since the form boards may be butted together at an angle in consecutive lengths of conduit and will still provide a satisfactory support or form for the concrete. Considerable local variation in the level of the conduit base and the level of the conduit is permitted by packing up the hoop member from the base and then tightening up the nuts 182a, when concrete is poured the concrete will form additional thickness of base at such low points. The usual practice of carefully levelling the ground preparatory to laying conduit is greatly simplified by my method of construction.

I may wish to provide expansion joints where extended lengths of conduit is laid above ground in areas such as deserts in which an extreme range of temperature is encountered. While various forms of joint may be utilized, the construction shown in Fig. 9 incorporates advantageously the elements illustrated in Figs. 1 through 6. A bell mouth 102 is formed by the use of a member 114 of larger diameter than member 112, but of similar construction to member H. To member 114 is secured a stamped annular metal packing piece 105 which extends across the edge of the bell and provides a tapered packing retainer holding water tight packing 106. The packing is put under pressure by a follower ring tightened by bolts 107 embedded in the edge of the bell and passing through holes in the follower ring and nuts threaded on said bolts bearing against said ring.

It will be evident that the forms or shuttering of my invention may be erected, concrete poured and set, the forms removed and with new spacers may be re-used indefinitely so that culverts and the like may be built section by section with a minimum wastage of parts and with no loss in accuracy.

I claim:

1. A method of forming horizontal tubular concrete structures comprising forming a horizontally extending base slab, with embedded laterally projecting retaining members; mounting hoop-like spacers along said base and securing the same to said retaining members; securing longitudinal and circumferential reinforcing rods in position relatively to said spacers; placing external retaining bands around but spaced from said spacers and securing the same to the retaining members, positioning outside planking between said retaining bands and hoop-like spacers; positioning expandable inside hoop members within said hoop-like spacers, positioning inside planking between the expandable hoops and hoop-like spacers, then filling the space between said outer and inner planking with concrete and then removing the planking, external bands and expandable hoops for re-use, leaving the hoop-like spacers embedded in the concrete of the structure.

2. A method of forming horizontally extending tubular structures of reinforced concrete, comprising forming a longitudinally extending horizontal base slab, positioning preformed hoop-like members with inner elements lying in the inner surface of the tubular structure and outer elements lying in the outer surface of the tubular structure, at predetermined positions along said base and securing the hoop-like elements to said base, arranging reinforcing elements longitudinally between the inner and outer elements of the hoop-like members and at spaced intervals therearound, fitting outer straps around but spaced from the outer members of the hoop-like elements and temporarily attaching the ends of said straps to the sides of the base, positioning outer form boards between said straps and hoop-like members, placing extensible diameter rings in contracted condition within and spaced from the inner members of the hoop-like elements; positioning boards in contact with one another between said expandable rings and the hoop-like member to form inner form face and expanding said rings to firmly hold the boards in position, then pouring concrete between the said inner and outer form boards, and then removing said straps, contracting and removing said expandable rings and the outer and inner form boards for re-use.

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